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A Modular Multilevel DC/DC Converter With Operating Region of Fault Blocking Capability for HVDC Interconnects By SVPWM

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Abstract -The Modular Multilevel Converter is another arrangement in the field of medium and high power electronics. The working operation of converter is depend on modular approach. The circulating current which affects both the arms are compensated by the half and full bridges integrated as a proposed approach in this work which comprises of modules, every one being a half-bridge associated in parallel to a capacitor. The fundamental characteristics behind this idea are that it is conceivable to construct the sinusoidal waveform of the voltage by including a few modules in arrangement in each phase leg of the converter. An arm inductance is associated in arrangement with the modules of each arm. As opposed to the two level voltage source converter, where the yield phase voltage can be either give or take the half of the dc-interface voltage, the MMC can change its yield with steps equivalent to every module capacitor's voltage level.

Keywords –MMC , HVDC, VSC,SVPWM fault blocking capability.

I. INTRODUCTION

HVDC technology based on Voltage Source Converters (VSC-HVDC) is the successful and environmentally-friendly way to design a power transmission system for a submarine cable, an underground cable, using over head lines or as a back-to- back transmission. Combined with extruded DC cables, overhead lines or back-to- back, power ratings from a few tenths of megawatts up to over 1,000 MW are available. VSC-HVDC is based on Insulated Gate Bipolar Transistors (IGBT) and operate with high frequency pulse width modulation in order to achieve high speed and, as a consequence, small filters and independent control of both active and reactive power and they offer several advantages compared to earlier HVDC classic technology based on Current Source Converters (CSC-HVDC) using thyristors.

Modular Multilevel Converters (MMCs) have gained researcher's attention due to their ability to handle high voltage and power ratings. VSC-HVDC is getting increasingly important for integrating renewable energy sources such as large offshore wind farms, providing flexible interconnection between two weak AC grid network using back-to-back configuration, or simply transmitting power using underground cables. The VSC-HVDC also has fast and precise control over the active power-flow as well as it can independently control the reactive power injection at the local ac grid. There are numerous operational MMC-HVDC projects such as HVDC PLUS (Siemens) with an 88 km undersea transmission link between San Francisco's City Centre electrical power grid and a substation near Pittsburg. The main supporting functions HVDC PLUS provides are AC voltage Control, black-start capability, compact converter station space usage, four quadrant operation, compensation of asymmetrical loads, and flexible integration into HVDC multi terminal systems or future HVDC grids.

As it can be shown in Figure 1.1, the circuit structure of MMC consists of three phase legs, each comprising of two arms connected in series between the dc-link. There are N number of Sub Modules (SM) in each arm in series with the arm inductor and resistor. The main objective of the inductor is to limit the surges in the arm current and also arm current harmonics; thus they are significant in the control of circulating currents. The resistances are operational variables, as they model the converter losses and the resistances of the inductor.

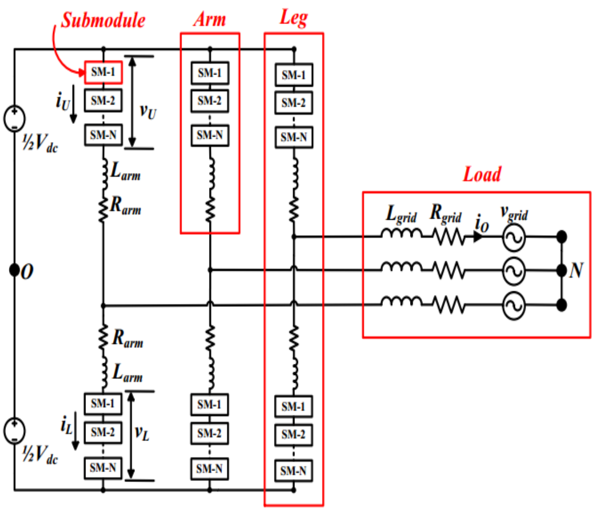

Figure 1.1 Modular Multilevel Converter Structure.

MMC replaces each semiconductor in the 2L converter with a structure of a cascaded submodules and an inductor, shown in Figure 1.1.

This structure is called arm. The structure of cascaded submodules are the basic motive of "multi level" voltage appearing at the output. The arm above the output terminal is named upper arm, and the below is named lower arm. The arm inductor isolates the upper and lower arm when they switching and prevents higher current flow between these two arms. The inductor acts as a filter also for output current.The upper and lower arm forms a leg which is the hardware section of MMC for one phase. Three legs constitute a three-phase MMC as shown in Figure 1.1. The legs are connected to a common DC-link.

The phase-shifted carrier-based PWM (PSC-PWM) method can naturally suppress all low-order harmonics for multilevel converters. The details of the modified PSC-PWM method for one pair modules in upper and lower arm . The reference waveform for upper and lower arm is complementary. Comparing the carrier duty cycle waveform (vp_ref , vn_ref) with the triangle wave, the signal state condition of upper and lower module can be achieved. When half-bridge module is used, there are two switching states. The ‘ 1 ’ state denotes when the upper switch is “on” and lower switch is “off;” the dc storage capacitor is connected in the phase. The ‘0’ state denotes when the lower switch is “on” and the upper switch is “off.” In the “0” state, the capacitor is bypassed from the phase arm. With the state condition of upper and lower module (S1and S2), a sinusoidal output can be generated.

II. MODULAR MULTILEVEL CONVERTER

High voltage direct current (HVDC) transmission systems utilize direct current for the bulk transmission of electrical power. It is an alternative to the three-phase AC transmission of electric power, especially for several specific conditions. For example, HVDC transmission is preferred for the applications of transmission under water, energy trade between countries and transmission over long distances.

HVDC technology has transformed from thyristor based line commutated current source converters (LCC) to 2L- and 3L-VSCs [8], and finally to modular multilevel converters, shown in Figure 1.5. The converters may be placed in the same site with zero DC line which is named as back-to-back HVDC. Alternatively, a DC line can also be used. Currently, MMC is utilized as HVDC technology with commercial names Siemens’s "HVDC Plus" [7], ABB’s 4th generation "HVDC Light.

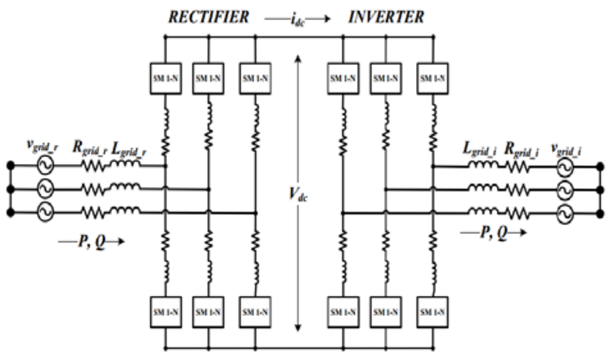

Fig. 2.1 MMC based HVDC model.

Grid-connected high-power converters are found in high-voltage direct current transmission (HVDC), static compensators, and supplies for electric railways. Such power converters should have a high reliability, high efficiency, good harmonic performance, low cost, and a small footprint. Cascaded converters appear to be promising for grid-connected applications since they can generate multilevel waveforms and thus combine good harmonic performance with low switching frequencies. This results in a high efficiency and eliminates the need for additional filters. The use of cascaded building blocks (sub modules or cells) also provides redundancy, which can be used to increase the reliability. One of the most important multilevel topologies for grid applications is the modular multilevel converter (MMC) presented in.

The purpose of the arm inductors is to limit parasitic currents and fault currents [3]. In order to limit the parasitic current, the required arm inductors are typically very small [4]. However, in grid applications, the arm inductors may be in the range of 0.1 p.u. in order to limit fault currents [5]. Accordingly, the sizes of the inductors in the considered applications are determined by external factors and not by the inherent properties of the MMC. Hence, this thesis will mainly focus on the energy storage elements and the rated power of the semiconductors.

III. PROPOSED SYSTEM MODEL

This proposed work presents a modular multilevel inverter DC/DC converter with adjustable for operating region of fault blocking capability for HVDC interconnect by SVPWM. a modular multilevel elimination of Space vector pulse modulation methods. SVPWM methods presented for the proposed of elimination of selected HVDC. The switching angles which are well separated can provide enough time for completion of consecutive transitions which can effectively reduce the switching losses and probability of switching damage in inverter bridges, improve the performance of PWM strategy, and extend life of inverter as well as the whole equipment. It is adaptable for an assortment of utilization necessities. The programmed method based on computer calculations generates a high quality output waveform through elimination of specific lower order harmonics. The critical factor which can heavily impact the calculation convergence is initial values. The selection of a group of bad initial values leads to a much longer calculation time and create wrong solutions. Figure 3.1 shows the Matlab Implementation of proposed modular multilevel converter with operating fault blocking capability for HVDC inter connect SVPWM.Figure 3.2 Show the proposed 1 Cell with Half Bridge &1 Cell with Full Bridge.

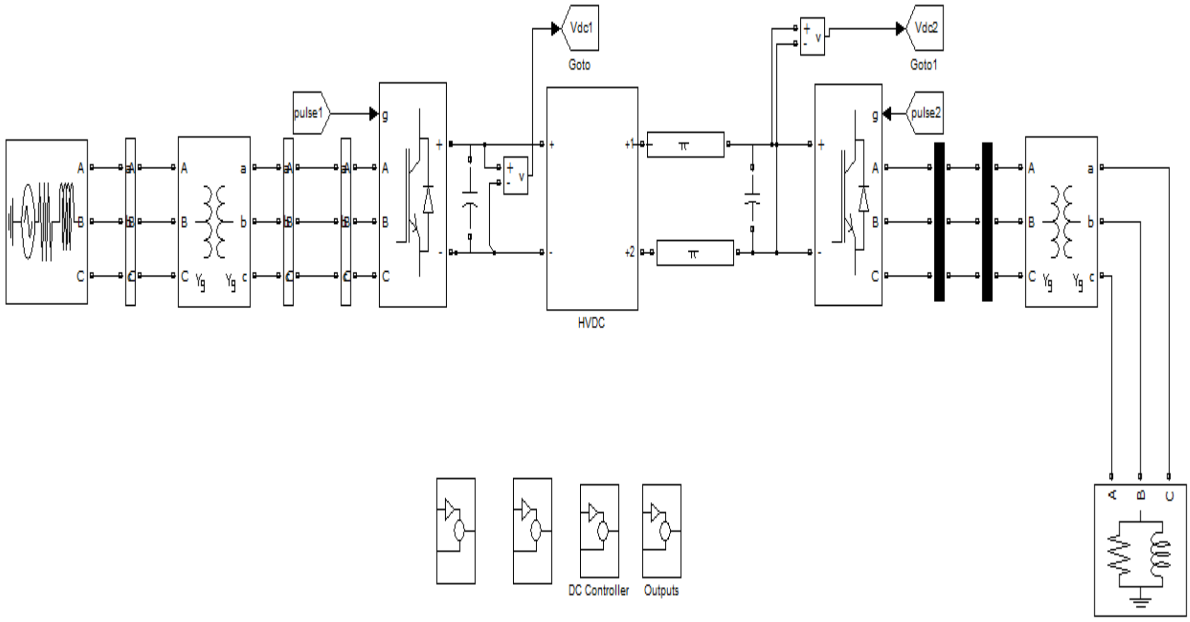

Fig.3.1A Modular Multilevel DC/DC Converter With Operating Region of Fault Blocking Capability for HVDC Interconnects By SVPWM.

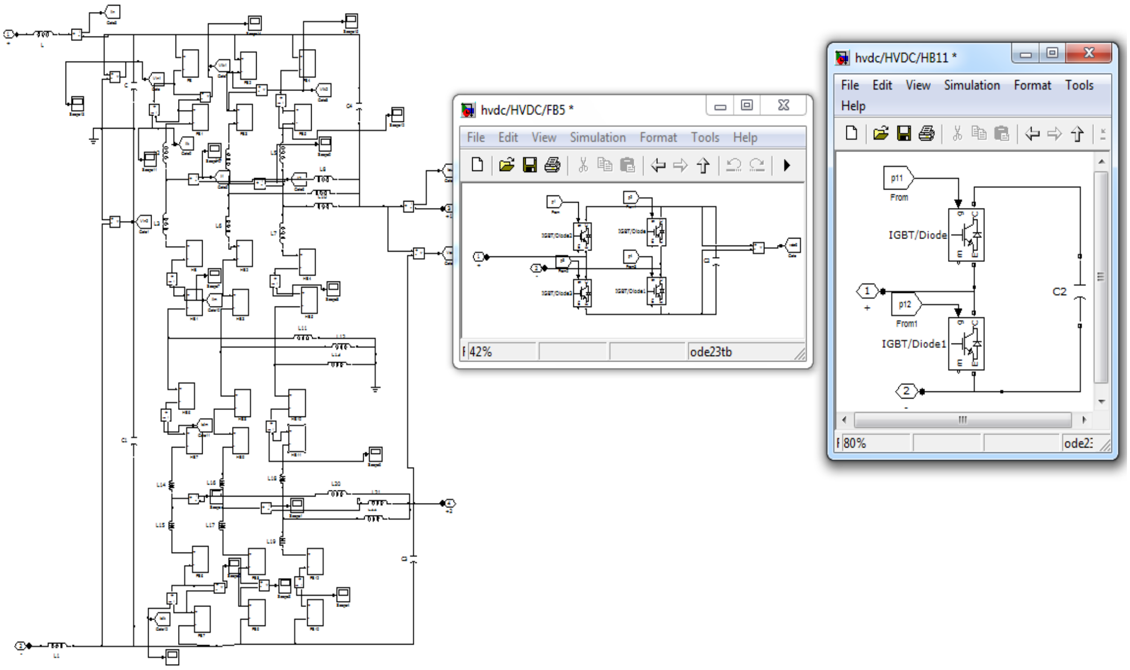

Fig.3.2Proposed model 1 Cell with Half Bridge &1 Cell with Full Bridge.

A control circuit operation and control loop with SV-PWM of proposed model has been shown in figure 3.3.reative power for ensuring operation can be performed using Sting compensator devices such as SV-PWM. And figure 3.4 show the proposed HVDC Station Circuit Model.

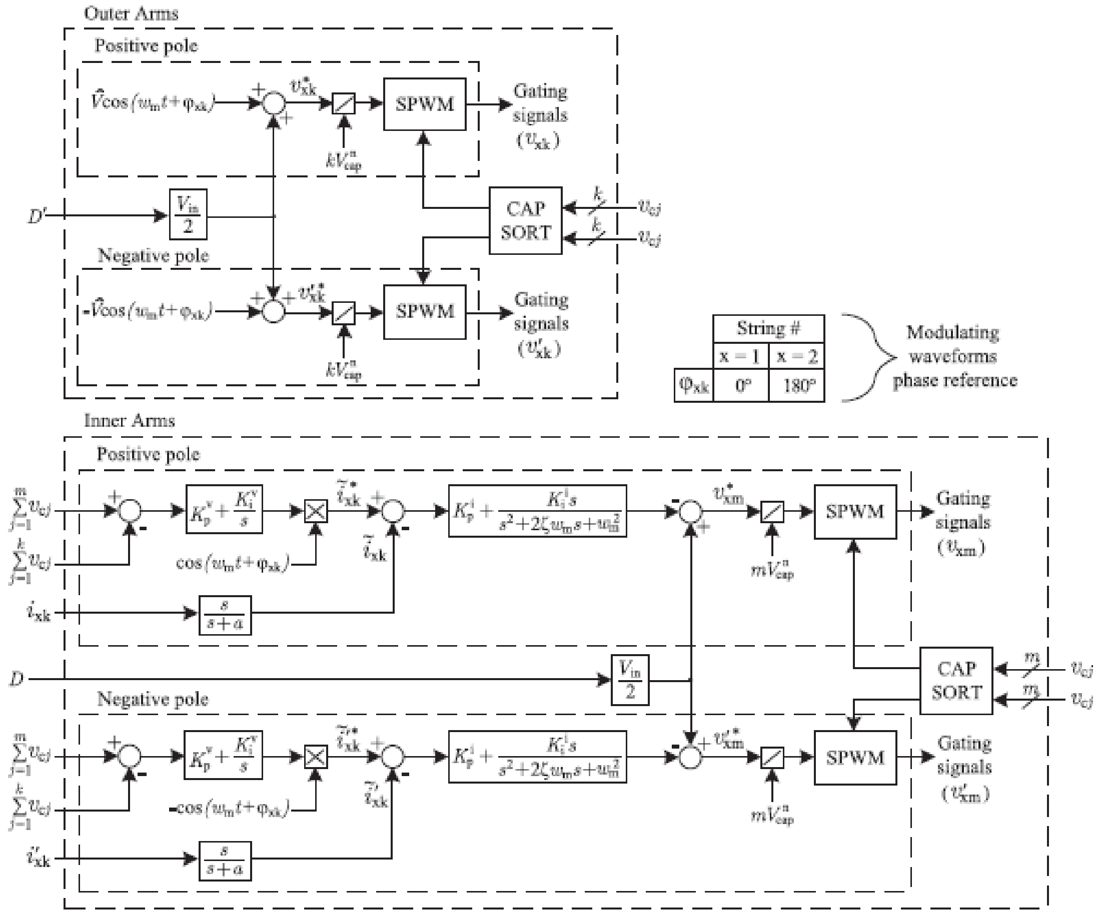

Fig. 3.3 Proposed control loop each string is compensated by SVPWM

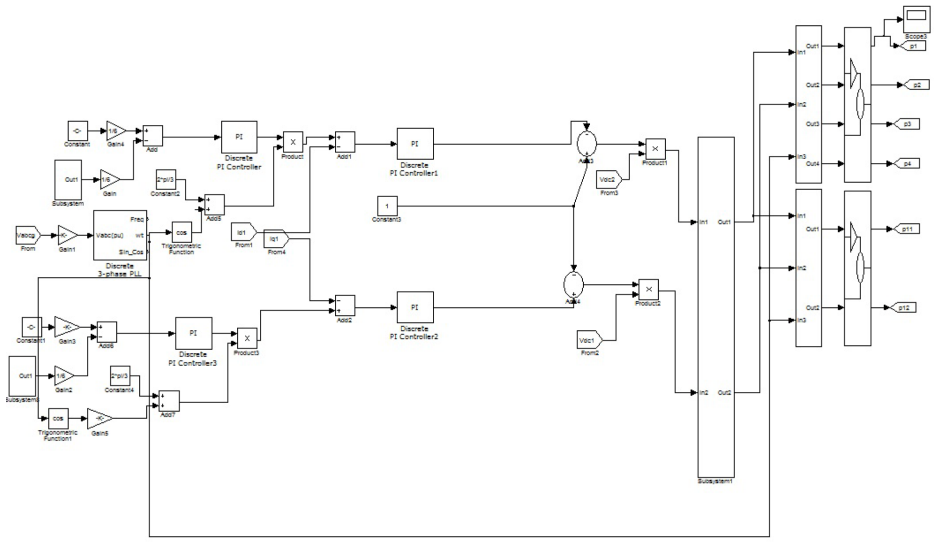

Fig.3.4 HVDC Station Circuit Model

IV. SIMULATION RESULTS

Here the simulations were done on the matlab simulink, the above diagrams show the voltage and current waveform of the modular multilevel converter. In the simulation that we performed for the modular multilevel inverter with the selected Grid voltage for the each inverter and lagging load is considered to included effects of the situations.

Here the concept of the selective harmonic elimination is applied in the firing circuit which was not shown which is hard to understand at this moment but the main observation which we should consider is in the output voltages for different modulation indexes is due to the error in the solution vectors of the switching angles and the truncation and the rounding off errors in this digital simulation results the improper functioning of the total simulation circuit that is the desired harmonics which should be eliminated are not completely getting eliminated.

Simulation outcome waveform of proposed work has been shown in below figures. In figure 4.1 a three phase grid voltage &current waveform of proposed system has been shown.

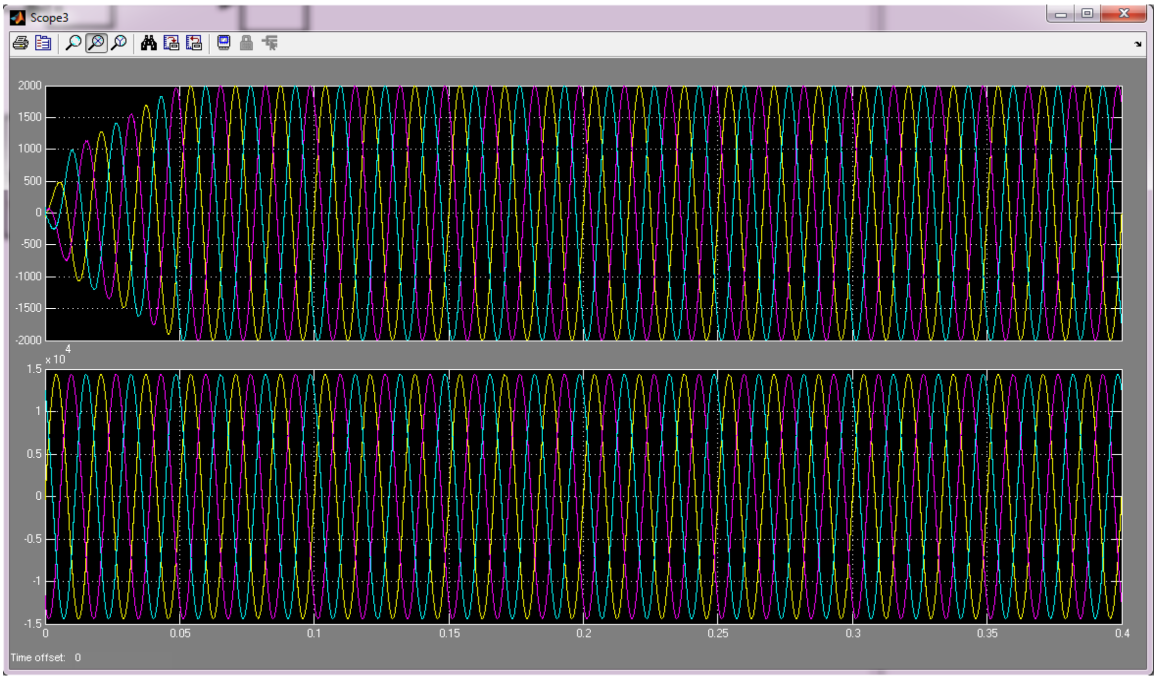

Fig.4.1Three Phase Grid Current and Voltage

HVDC current waveform of proposed system has been shown in figure 4.2 and HVDC voltage waveform of proposed model has been shown in figure 4.3.

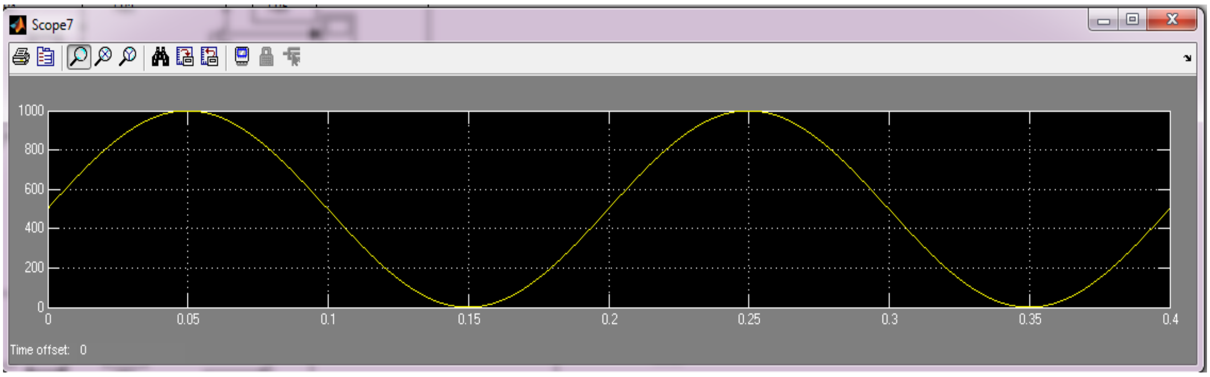

Fig.4.2 HVDC Current.

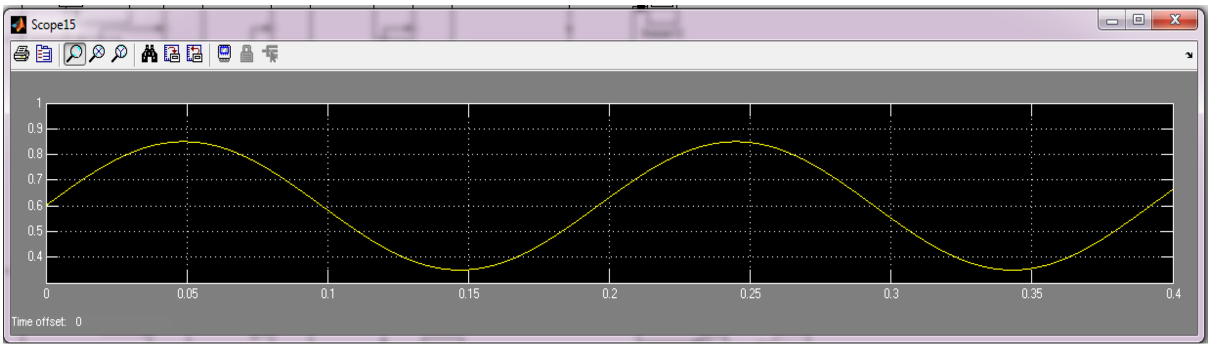

Fig.4.3 HVDC Voltage.

In figure 4.4 a DC voltage output has been shown. the main advantage of the proposed work which is used is simplicity in the control for large number of the modules in the DC-DC multilevel inverter.

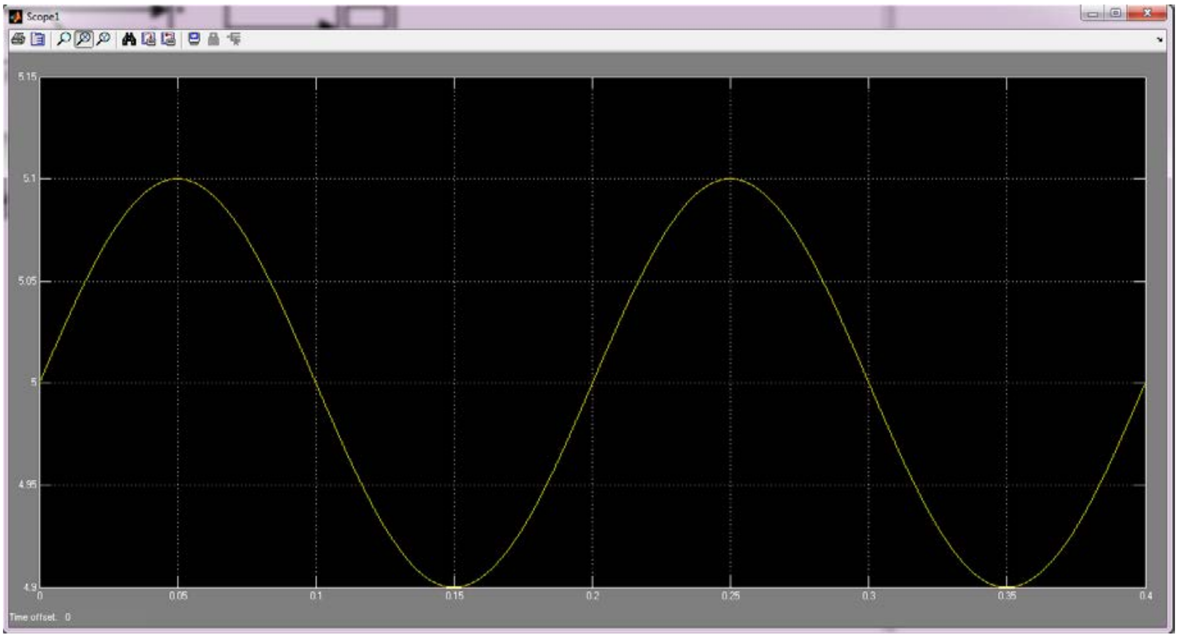

Fig.4.4 Output Voltage

V. CONCLUSION AND FUTURE SCOPES

In this work efficient method for high voltage direct current (HVDC) modular multilevel converter has explored and presented an efficient method foe HVDC application for reduced harmonics and power distortions as demonstrated with the help of waveform in chapter 5. The proposed approach utilizes the full and half bridge hybrid multi level structure to control the circulating current harmonics and SVPWM controlling mechanism in upper and lower arm for remaining distortions presents in the system. The half and full bridge efficiently reduce the effect of injected second order harmonics by circulating and compensates the reactive power capability of MMC system.

In future the system can be integrated with the different controllers like PI Controller with Fuzzy logic controller to achieve desirable system requirements in various HVDC applications.

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